

# Educational Transformation in the Era of Artificial Intelligence

Felip Manyà

Artificial Intelligence Research Institute (IIIA), Spanish National Research Council (CSIC), Bellaterra 08193, Spain

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**Abstract** The integration of artificial intelligence (AI) in education is reshaping how learning is designed, delivered, and governed. This study examines five interrelated domains: integrating AI in education, learner development and personalization, curriculum and educational content, role of teachers, and governance and regulation. It argues for systemic, ethically grounded educational approaches that promote equity, lifelong learning, and collaborative policymaking.

**Keywords** artificial intelligence in education, personalized learning, lifelong learning, governance, ethics, educational content

## 1 Introduction

Rapid advancements in artificial intelligence (AI) are reshaping the foundations of education systems worldwide. As AI technologies become increasingly embedded in everyday life, they are transforming teaching, learning, and educational governance in complex and varied ways that require a multidisciplinary approach. This transformation is not merely technological; it is also pedagogical, ethical, and organizational (Hu et al., 2025).

Traditional models of education prioritize standardization, memorization, and predictable careers and are proving insufficient in today's world that is characterized by complexity, uncertainty, and constant change. In this context, education must evolve to cultivate adaptive, creative, and ethically grounded learners who can navigate and shape a future AI-driven society (Hariyanto et al., 2025).

The multidisciplinary field of AI in education (AIED) aims to address these challenges. AIED combines insights from computer science, cognitive psychology, pedagogy, and data analytics to innovate teaching, learning, and educational governance. To

guide this shift, AIED must advance on two fronts: universal AI literacy for all learners and advanced training for AI specialists.

This study explores the multidimensional transformation of education in the AI era with a focus on five interrelated domains: integrating AI in education, learner development and personalization, curriculum and educational content, role of teachers, and governance and regulation. It argues that AI should not be viewed solely as a tool for efficiency or automation but as a catalyst for reimagining education as a more inclusive, personalized, and lifelong process. The integration of AI into education raises critical questions about equity, data ethics, teacher empowerment, and the preservation of human-centred values in increasingly digital learning environments. Education should not merely implement AI technologies; it should also be a proactive agent in shaping the ethical and civic dimensions of AI policy (Schiff, 2022).

The study highlights how educational systems are beginning to respond to these challenges. From the personalization of learning pathways through AI-enhanced platforms to the development of interdisciplinary curricula that connect technical disciplines with the humanities, the transformation is underway, though it may be uneven and is often fragmented. Moreover, the governance of AIED remains a pressing concern, and robust frameworks are required to ensure transparency, accountability, and public trust (Capuano & Caballé, 2020; Hariyanto et al., 2025).

Ultimately, this study contends that education must be guided by a commitment to human development, social cohesion, and shared values. It calls for a systemic and collaborative approach that empowers all educational actors—learners, educators, policymakers, and developers—to co-create a future of education that is not only technologically advanced but also ethically sound and socially just (Urmeneta & Romero, 2024).

## 2 Integrating AI in Education

The emergence of AI has transformed educators' and learners' use of technology by not only enhancing their

activities in specific contexts but also enabling the outsourcing of certain educational processes that might otherwise impede the effort needed to develop new competencies. Education has historically often focused on uniformity, memorization, and preparing students for predictable careers. However, modern education must prepare learners to operate in a world that is constantly evolving. This shift demands that we prioritize adaptability, computational thinking, problem-solving, creativity, critical thinking, collaboration, and ethical reasoning (Chasokela & Hlongwane, 2025; Urmeneta & Romero, 2024). While these were formerly optional competencies, they are now core competencies for students to succeed in modern society.

Education must equip all learners and citizens, not just specialists, with a foundational understanding of AI that should be critically evaluated (Walter, 2024). This includes how algorithms work, how data is collected and used, and what social impacts AI may produce. At the same time, educational systems must develop specialized talent in areas such as data science, robotics, and machine learning to drive innovation.

Science, technology, engineering, and mathematics (STEM) education remains essential, particularly in vocational training. However, its role is evolving. Today, STEM not only demands technical proficiency and computational thinking but also cultivates higher-order skills such as ethical reasoning, creativity, and the ability to apply knowledge in real-world contexts. This shift underscores the growing importance of an interdisciplinary approach—one that connects technical expertise with the humanities and social sciences—to prepare learners for the multifaceted challenges of an AI-driven society (Xie et al., 2024).

A compelling example of this evolution is the Bachelor's degree in Artificial Intelligence at the Autonomous University of Barcelona (UAB, 2025). This program offers comprehensive training that equips students to design intelligent systems capable of addressing societal needs. Learners delve into the cognitive, mathematical, and algorithmic foundations of automated reasoning and machine learning and gain the skills required to develop AI applications across domains such as natural language processing, computer vision, robotics, and autonomous agents. Crucially, the curriculum also emphasizes the ethical, legal, and social implications of AI, and it encourages students to critically assess the impact of the technologies they create.

The emergence of computational approaches in the social sciences, in general, and the learning sciences, specifically, affords an opportunity to advance research in the learning sciences through the computational potential of learning analytics and the use of AI-driven methodologies for exploiting generated data more intensively by using technology-mediated tools.

Worldwide, education systems are challenged by these needs. Some are updating curricula to integrate digital and AI literacy (Ng et al., 2024), whereas others are fostering partnerships between schools and industries to make learning more relevant and future-ready. All these efforts reflect the growing understanding that education is no longer just about acquiring knowledge; instead, it requires preparing individuals to think critically, act ethically, and learn continuously in a fast-changing world.

### 3 Learner Development and Personalization

One of the major benefits of AIED solutions is that they can support learners' needs in a more personalized way (Capuano & Caballé, 2020). AIED platforms such as Squirrel AI (China) and Century Tech (UK) can adapt standardized curriculum pathways in real time. For example, Squirrel AI uses adaptive algorithms to adjust the content difficulty and pacing based on individual performance, resulting in significant gains in math and science proficiency among diverse student populations. Similarly, Duolingo's AI-driven language learning personalizes exercises according to users' mistakes, thereby increasing their engagement and retention rates. To help learners thrive in the AI era, educational systems must integrate these tools into flexible structures that support lifelong learning—such as micro-credentialing platforms (e.g., Coursera's modular courses) and hybrid learning environments that combine in-person and digital interaction.

The traditional boundaries between basic education, higher education, and professional training need to be removed; collaboration is needed to create the AI literacy pathway, especially considering that the potential utility of AIED tools could increase across learners' lifespan. A modern system should allow learners to move fluidly across different formats and stages depending on their life goals and personal development. Learning should happen not only through formal institutions but also through online courses, community initiatives, and workplace learning (Urmeneta & Romero, 2024).

AI can be used to make this lifelong adaptability easier. Smart learning platforms can analyse how each student learns and adjusts the content, pacing, and feedback accordingly. This helps students master the study material at their own speed and in their own style. It also allows educators to intervene earlier and more precisely when support is needed.

Lifelong learning must become a structural goal to address the need for a higher level of education to adapt to AI challenges. It requires investment in adult

education, short-term training options, micro-credentials, and modular programs that workers and citizens can access at any stage of life. An example of such initiatives is the European Union's Artificial Intelligence for Adult Learning project (AI4AL, 2023).

Ultimately, transforming education for adaptive development is not just about technology. It should be an invitation to design systems that are inclusive, responsive, and human-centred. Learners must be supported as individuals who are each on different paths, rather than being treated as parts of a uniform process. Hybrid intelligence approaches should consider the strategic role of technology in education to ensure that teacher agency and learner competencies and well-being remain at the centre of education as a human and relational process.

## 4 Curriculum and Educational Content

Educational content must evolve to reflect new knowledge, new technologies, and new learner needs. The structure of the content and curriculum must be more flexible and interdisciplinary in nature. AI, data literacy, and digital ethics should be integrated across subjects rather than being treated as independent courses. Currently, the integration of AI is often associated with technological courses (Abbasi et al., 2025). However, this could limit the awareness of AI implications in other curricular areas.

Cross-disciplinary content prepares learners to solve real-world problems in which technology, culture, and policy often intersect. The development of interdisciplinary AI courses for students from different college specialties could help to overcome this limit (Cai et al., 2025), alongside the development of interdisciplinary courses and activities at the primary and secondary education level (OECD & European Commission, 2025).

Learning activities and open educational resources (OER) should also be designed to support personalized learning. Standardized textbooks, traditional materials with fixed content, and resources can be made more effective by integrating personalized learning paths that reflect learners' needs. AI enables content to be adapted in real time to students' progress, interests, and goals. This means learners can move at their own pace, explore topics they are passionate about in greater depth, and receive targeted support when needed in the learning journey (Clément et al., 2024).

Global practices show a move toward modular content, characterized by short, focused learning units that can be mixed and matched based on a learner's path. These modules allow for greater customization

and make learning more relevant to personal goals or job markets. The microlearning approach supports this trend by delivering content in manageable segments, enhancing retention, flexibility, and the ability to adapt learning to individual needs and rapidly changing professional environments.

Content must also become more inclusive. It should reflect different perspectives, cultures, and languages while considering the need to ensure the preservation of minoritised languages in different educational contexts in which there is a convergence in the use of a main language. Such needs are seen worldwide, for example, in the case of Polynesian languages facing English and French influences as well as the Catalan language in relation to the Spanish language (Department of Education of the Government of Catalonia, 2018).

## 5 Role of Teachers

The role of teachers is being challenged by worldwide teacher shortages (White et al., 2025) and by AI-driven changes to teacher agency. AI could take over routine tasks such as grading, tracking progress, and delivering basic instruction, thereby freeing teachers to focus on guiding thinking, supporting emotional development, and creating meaningful learning experiences. However, this potential depends on responsible design and deployment: Attention to bias, privacy, unequal access, and the risk of added oversight work are needed to ensure AI truly empowers teachers rather than creating new burdens.

Teachers are becoming facilitators and designers of learning environments, not just providers of information. To succeed in this new role, they need to acquire the ability to interpret AI-generated feedback, integrate digital tools effectively, and foster student agency and collaboration.

AI is also changing how knowledge and competencies are taught and assessed. Instruction is moving toward blended models that combine in-person and digital interaction. Teachers have reported their frustration with learners' use of AI for completing their homework, and they are reconsidering the way assessments are developed to ensure the originality of learners' work. In educational contexts with a high use of technology-enhanced learning support such as some online universities, assessment is becoming more formative and data-driven, allowing teachers to personalize feedback and better understand each learner's journey.

Teacher training must evolve too. Educators need structured opportunities to build digital confidence, experiment with AI-supported methods, and

learn how to critically evaluate new tools. Global trends point to a growing focus on professional learning communities and mentorship models that help teachers learn from one another as they adapt to new roles, such as the Community for Educational Reflection on Artificial Intelligence launched by the Digital Education Department of the Ministry of Education in France.

Teaching in the AI era is about balance. AI can support instruction, but human insight, empathy, and judgment remain essential. Teachers should not be replaced; they need to be re-empowered to do the work that truly matters in the relational aspects of education that makes a difference (Rubie-Davies & Hattie, 2025). This demands that professional development explicitly focus on cultivating hybrid intelligence skills: Helping teachers master the synergy between their human judgment (empathy, ethical reasoning) and the analytical power of AI tools to create superior learning outcomes.

## 6 Governance and Regulation

The integration of AI in education requires a shift in governance from passive facilitation to active, responsible guidance. This involves the development of clear and forward-looking policy frameworks that define the role of AI in learning environments; promote ethical use; and support broader societal goals such as inclusion, equity, and democratic participation.

Regulatory instruments, such as the AI Act (European Commission, 2024), play a critical role in ensuring safety, transparency, and accountability (Aler Tubella et al., 2024). However, regulation must be carefully designed to avoid stifling innovation. Legal frameworks should safeguard student data, clarify intellectual property rights over educational content, and prevent algorithmic misuse in sensitive areas such as admissions and assessment. One of the most pressing challenges is ensuring AI explainability, namely, that the decisions made by AI systems must be transparent, auditable, and aligned with pedagogical values such as promoting deep conceptual understanding, facilitating collaborative discovery, and encouraging student agency, rather than solely technical efficiency.

In addition to legal safeguards, education systems must establish standards and promote the development of OER that define the characteristics of high-quality AI tools. These standards should address how AI supports teachers, interacts with students, and contributes to meaningful learning processes. In the absence of shared criteria, the risks of deploying ineffective or biased technologies increase, potentially exacerbating existing inequalities.

Governance also entails institutional

capacity-building and stakeholder empowerment. Ministries of Education and school leaders must collaborate with educators, developers, and researchers to identify effective practices and avoid pitfalls (UNESCO, 2021). Several countries have already established dedicated agencies or task forces to oversee AI integration in education, reflecting a growing recognition of the need for institutional innovation to maintain public trust and uphold core educational principles.

A major challenge lies in the rapid pace of technological change, which often outstrips policy development. This creates blind spots in areas such as algorithmic bias, data privacy, platform accountability, and equitable access to AI-enhanced educational tools. While teachers and students have adapted to the platforms available to them, there is an urgent need to develop and disseminate tools that are pedagogically sound and contextually appropriate.

At the heart of every education system, a robust governance framework is needed to address ethical and security concerns. This includes protecting learners' data, ensuring transparency in AI systems, and preventing discrimination in automated decision-making. It also involves setting guidelines for the responsible design, implementation, and evaluation of AI tools in educational settings (UNESCO, 2023).

Finally, governance must be participatory. Teachers, students, families, developers, and researchers should all be involved in shaping how AI is used in education. This participatory approach ensures that decisions reflect real classroom needs and public values, rather than being driven solely by technological possibilities. School-level AI policy workshops can serve as a valuable mechanism for engaging educational communities in defining AI use and literacy activities by considering local resources and the willingness of stakeholders to participate in ongoing transformations.

## 7 Conclusions

The integration of AI in education presents both a significant opportunity and a profound responsibility. As AI-driven tools become more prevalent, there is an urgent need to support all educational stakeholders—learners, educators, institutions, and policymakers—through targeted upskilling and equitable access to AI-enhanced educational technologies. While AI offers powerful capabilities for personalization, efficiency, and expanded access to learning, its implementation must be guided by a commitment to equity, ethical integrity, and human development.

The challenge faced by educators and policymakers is not only to adopt new technologies but also to lead a systemic transformation that is inclusive,

adaptive, and grounded in shared public values. Success in this endeavour requires reimagining education as a lifelong, learner-centred process that fosters critical thinking, creativity, and social responsibility. Ultimately, the goal is not only to modernize education but also to shape it into a force for personal growth, social cohesion, and innovation in an increasingly complex and rapidly evolving world.

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